* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the optical pickup used for the optical recording playback equipment which plays the information on which the information over optical discs, such as CD and DVD, was recorded and recorded.
[0002]Drawing 37 is an outline lineblock diagram showing the conventional example of this kind of general optical pickup. the former -- an optical pickup -- one -- ' -- a laser diode -- (-- LD --) -- etc. -- constituting -- having had -- a light source -- two -- an object lens -- seven -- a light source -- two -- from -- a laser beam -- 90 -- a degree -- bending -- an object lens -- seven -- glaring -- a mirror -- six -- ' -- at least -- having -- **** . The recording medium 8 is set to the condensing position of the object lens 7. In addition, optical pickup 1' of drawing 37 has the wavelength plate 5 with the polarization beam splitter 4 between the laser diode 2 and mirror 6', and while is separated by the polarization beam splitter 4 and it has the photodetector 10 constituted from the condenser 9, a photo-diode, etc. by the optical path. The object lens 7 can be moved now via the drive control means which carried out the graphic display abbreviation in accordance with a direction and an optic axis parallel to a recording medium.
[0003]And in conventional optical pickup 1' constituted in this way, a laser beam is emitted from the light source 2, and turns into a parallel beam via the collimating lens 3. The laser beam used as a parallel beam enters into the polarization beam splitter (Tp=70%, Rs = about 100%) 4. Among the laser beams which entered, P polarization penetrates the polarization beam splitter 4, turns into circular light via the wavelength plate 5, and enters into mirror 6'. It reflects by mirror 6', is bent 90 degrees, it is condensed via the object lens 7, and irradiates with the recording medium 8. A reverse course is followed, it reflects again by mirror 6', and the laser beam reflected with the recording medium 8 is bent 90 degrees, turns into linear polarization via the wavelength plate 5, and enters into the polarization beam splitter 4 by S polarization. It is reflected by the polarization beam splitter 4, and the laser beam of S polarization is condensed via the condenser 9, with the photodetector 10, light is received and a servo signal and an information signal are acquired via the central processing unit etc. which carried out the graphic display abbreviation.
[0004]A focus error signal uses the beam size method, astigmatic method, etc. which are publicly known art among servo signals. Drive the object lens 7 to an optical axis direction, it is made to specifically defocus on

the recording medium 8, and the returned light to the photodetector 10 is detected in this state. A track error signal uses the Push-Pull method etc. which are publicly known art similarly. A focus error signal (defocusing amount) is detected by specifically detecting by driving the object lens 7 in parallel with the field of the recording medium 8. An information signal is acquired by detecting the light volume which received light with the photodetector 10.

[0005]

[Problem(s) to be Solved by the Invention]By the way, the recording medium used for the usual optical pickup is divided roughly into the thing of two kinds of different substrate thickness like CD whose substrate thickness is 1.2 mm, and DVD whose substrate thickness is 0.6 mm. However, in the optical system which constitutes the conventional optical pickup, when a condenser is justified in a prescribed position, it is designed like CD and DVD, for example so that generating of a spherical aberration may not arise according to either of the recording media with which substrate thickness differs. And the condenser which constitutes such an optical system, It is constituted using the lens and aspheric surface lens which ground and manufactured glass, The lens itself can be changed, a focal distance cannot be changed, since a reflection film is provided in the transparent member which glass etc. do not transform for mirror 6', either and it is constituted, mirror 6' itself can be changed and a focal distance cannot be changed. For this reason, when the recording medium of the substrate thickness of another side was set, the spherical aberration occurred, and the recording medium which is two kinds from which substrate thickness differs was not able to be outputted in the conventional optical pickup and inputted simultaneously.

[0006]In order to detect a focus error signal (defocusing amount), when making an optical axis direction drive an object lens, the drive for it was needed and mechanical structure was complicated. And since the motor etc. were used in order to move an object lens, the response time when a sound with loud power consumption is noisy was long, and there was a fault, such as that movement of a lens takes time and being connected with a cost hike.

[0007]Then, this invention can be outputted and inputted also to any of the recording medium of different substrate thickness in view of these problems, and ********** is small, a sound is quiet, response time is short, and mechanical structure is easy, and it aims at providing the optical pickup which contributes to a cost cut.

[0008]

[Means for Solving the Problem]In order to attain the above-mentioned purpose, an optical pickup by this invention, In an optical pickup of optical recording playback equipment which has at least a light source, an object lens, and a reflective mirror that bend a laser beam from a light source 90 degrees, and with which an object lens is irradiated, Said reflective mirror comprises a variable mirror provided with a mirror surface where shape changes, and a face shape variable means to which shape of said mirror surface is changed.

[0009]In an optical pickup of optical recording playback equipment which has a reflective mirror with which an optical pickup by this invention bends a light source, an object lens, and a laser beam from a light source 90 degrees at least, and an object lens is irradiated, and a recording medium, By said reflective mirror's comprising a variable mirror provided with a mirror surface where shape changes, and a face shape variable means to which shape of said mirror surface is changed, and changing shape of this mirror surface, It

enabled it to make said laser beam condense to said recording medium with which substrate thickness differs, so that input and output are possible.

[0010]

[Embodiment of the Invention]Hereafter, the example of this invention is described using a drawing. Drawing 1 is an outline lineblock diagram showing one example of the optical pickup by this invention. The optical pickup 1 of this example is provided with the variable mirror 6 provided with the face shape variable means to which the shape of the mirror surface where shape changes instead of and this mirror surface is changed, and is constituted. [mirror 6' which was provided in optical pickup 1' shown in drawing 37, and not changing] The recording medium 8 is set to the condensing position of the object lens 7. In addition, the optical pickup 1 of this example has the wavelength plate 5 with the polarization beam splitter 4 between the laser diode 2 and mirror 6', and while is separated by the polarization beam splitter 4 and it has the photodetector 10 constituted from the condenser 9, a photo-diode, etc. by the optical path.

[0011]And by changing the shape of the mirror surface of the variable mirror 6, a spherical aberration is made to reduce, and it comprises the optical pickup 1 of this example so that a laser beam can be made to condense so that input and output of two kinds of recording media with which substrate thickness differs may be attained.

[0012]The object lens 7 of conventional optical pickup 1' shown in drawing 37 is optimized to the recording medium of 0.6-mm substrate thickness, and the spherical aberration over the recording medium of 0.6-mm substrate thickness has a good value by image height abbreviation 1deg, as shown in drawing 2 (a). However, as shown in drawing 2 (b) to the recording medium of 1.2-mm substrate thickness, a spherical aberration occurs greatly in + side. Then, the variable mirror 6 enabled it to change the shape of a mirror surface in the optical pickup 1 of this example, when outputting and inputting the recording medium of this 1.2-mm substrate thickness, as shown in drawing 3 (a). Then, a spherical aberration is amended, and as mostly shown in drawing 2 (a), it can acquire a good spherical aberration. Therefore, according to this example, the optical pickup which can be outputted and inputted is realizable to the recording medium of two kinds of different substrate thickness.

[0013]Change of the shape of a mirror surface can carry out the variable mirror 6, and the optical pickup 1 of this example can also amend the aberration etc. which are generated according to the manufacture error of a recording medium with changing and constituting a way. Then, those examples of composition are explained below. In a high-density optical pickup with high NA of an object lens, the influence of the spherical aberration generated according to the thickness error of a recording medium is great. Then, in the optical pickup 1 of drawing 1, if the variable mirror 6 is constituted deformable in shape as shows drawing 3 (b) the shape of a mirror surface, the spherical aberration by the side of + can be amended, and if constituted deformable in shape as shown in drawing 3 (a), the spherical aberration by the side of - can be amended.

[0014]A coma aberration occurs by inclination of a recording medium and curvature. Then, a coma aberration can be amended if the variable mirror 6 is constituted deformable in shape as shows drawing 3 (c) and drawing 3 (d) the shape of a mirror surface. Since a coma aberration is generated in inclination and curvature of the radial direction of a recording medium, a radial coma aberration is amended, but it may

usually generate in a radius vector direction. In this case, amendment of a two-dimensional coma aberration is attained by constituting the variable mirror 6 deformable in the direction of two dimensions as it is also at shape as shows drawing 3 (c) and drawing 3 (d) the shape of a mirror surface. It also becomes possible to amend a spherical aberration and a coma aberration simultaneously by constituting deformable in the shape which combined further again shape which shows the shape of a mirror surface to drawing 3 (a) - drawing 3 (d) for the variable mirror 6.

[0015]He is trying to detect the focus error signal shown in drawing 5 by changing the shape of the mirror surface of the variable mirror 6 in the optical pickup 1 of this example, as shown in drawing 4 (a) - (c). As mentioned above, in conventional usual optical pickup 1' shown in drawing 37, the focus error signal (defocusing amount) was detected by driving the object lens 7 to an optical axis direction, making it defocus on the recording medium 8, and detecting the returned light to the photodetector 10 in this state.

[0016]On the other hand, the optical pickup 1 of this example makes a parallel beam sending light and a converged beam, respectively, and makes drawing 4 (b) and (c) produce defocusing on the recording medium 8 by changing the shape of the mirror surface of the variable mirror 6 into a convex and a concave surface so that it may be shown. A signal (the same signal as a focus error signal) as this shows to drawing 5 to the deformation of the mirror surface of the variable mirror 6 is acquired. Therefore, it becomes possible to detect a focus error signal like the case where it is based on the drive of the object lens 7 used in conventional optical pickup 1' according to the optical pickup 1 of this example, If modification of the mirror surface of the variable mirror 6 is controlled so that a signal output becomes zero, a laser beam can be made to always condense on the recording medium 8, so that input and output are possible. (This is called focus servo).

[0017]As shown in drawing 6 and drawing 7 (a) - (c), the optical pickup 1 of this example, Even if it constitutes the variable mirror 6 the shape of a mirror surface so that it may become deformable only at a flat surface and a convex, as it is shown in drawing 8 and drawing 9 (a) - (c), the variable mirror 6 may be constituted so that it may become deformable on a flat surface and a concave surface about the shape of a mirror surface. Since modification of the mirror surface of the variable mirror 6 will serve as only one way, respectively if constituted like these, the composition of the variable mirror 6 can be simplified compared with the composition of drawing 37.

[0018]The permanent magnet or coil which has the transparent electrode divided into plurality as the variable mirror 6, and has been arranged the thing of the composition using piezoelectric material, and near the mirror surface, It has a member which can send the transparent current united with the mirror surface, and changing face shape according to electromagnetic force can use the thing of composition, etc. possible. Then, the concrete composition of a variable mirror applicable to the optical pickup of this invention is explained below using an example.

[0019]Drawing 10 is an outline lineblock diagram of the Kevlar type finder of the digital camera using the letter mirror of good modification applicable to the variable mirror used for the optical pickup of this invention. Of course, the composition of this example can be used also for a silver salt film camera. First, the variable mirror 409 is explained.

[0020]The letter mirror of optical property good modification which consists of the thin film (reflector) 409a in

which aluminum coating of the letter mirror 409 of good modification was carried out, and two or more electrodes 409b. (it is only hereafter called the letter mirror of good modification.) -- it is -- two or more variable resisters by which 411 was connected to each electrode 409b, respectively. The power supply by which 412 was connected with the variable resister 411 between the thin film 409a and the electrode 409b via the electric power switch 413, An arithmetic unit for 414 to control the resistance of two or more variable resisters 411, and 415,416 and 417 are the thermo sensors, the humidity sensors, and distance sensors which were connected to the arithmetic unit 414, respectively, and these are allocated like a graphic display and constitute one optical apparatus.

[0021]Each field of the object lens 902, the eyepiece 901 and the prism 404, the 2 equilateral rectangular prism 405, the mirror 406, and the letter mirror of good modification, The surface of a sphere, flat surface, symmetry-of-revolution aspheric surface which may not be flat surfaces and carried out eccentricity to the optic axis besides a surface of a sphere and a symmetry-of-revolution aspheric surface, Or what is necessary is just fields which can have a certain influence on light also by the reflector or a refracting interface further by carrying out what kind of shape, such as a field which has the aspheric surface which has a symmetry plane, the aspheric surface which has only one symmetry plane, an aspheric surface without a symmetry plane, a free sculptured surface, a point in which differentiation is impossible, or a line. Hereafter, these fields are named generically and it is called an extended curved surface.

[0022]The thin film 409a, for example The volume on P.Rai-choudhury, Handbook. of Michrolithography, Michromachining and Michrofabrication, Volume 2:Michromachining and Michrofabrication,P495,Fig.8.58, SPIE PRESS ** and Optics. Like Communication and the membrane mirror indicated to 140 P187 - 190 (1997), When voltage is impressed among two or more electrodes 409b, the thin film 409a changes according to electrostatic force, and the face shape changes, and by this, Modification the focus adjustment doubled with the observer's diopter scale does not come out as much as possible, and according further to the temperature and humidity of the lens 901,902 and/or the prism 404, the 2 equilateral rectangular prism 405, and the mirror 406, and change of a refractive index, Or the fall of the image formation performance by the assembly error of parts, such as elasticity, modification and the optical element of a lens frame, and a frame, is controlled, and amendment of the aberration always properly produced in focus adjustment and focus adjustment may be performed. What is necessary is for modification of the thin film 409a to carry out the form of the electrode 409b, and just to choose it according to a way, as shown, for example in drawing 12 and 13.

[0023]According to this example, it is refracted in each entrance plane and projection surface of the object lens 902 and the prism 404, and is reflected in the letter mirror 409 of good modification, and the light from an object penetrates the prism 404, It is further reflected with the 2 equilateral rectangular prism 405 (+ seal in drawing 10 and an optical path shows that a beam of light progresses toward the back side of space.), is reflected by the mirror 406, and enters into an eye via the eyepiece 901. Thus, in the lens 901,902, the prism 404,405, and the letter mirror 409 of good modification, the observation optical system of the optical apparatus of this example can be constituted, and aberration of an object face can be made now into the minimum by optimizing the face shape and thickness of each of these optical elements.

[0024]That is, the shape of the thin film 409a as a reflector is controlled by changing the resistance of each

variable resister 411 with the signal from the arithmetic unit 414 so that image formation performance may become the optimal. Namely, the signal of the size according to the distance from the thermo sensor 415, the humidity sensor 416, and distance SANSA 417 to ambient air temperature, humidity, and an object is inputted into the arithmetic unit 414, The arithmetic unit 414 outputs the signal for determining the resistance of the variable resister 411 so that the voltage that the shape of the thin film 409a is determined may be impressed to the electrode 409b that the fall of the image formation performance by the distance to a surrounding temperature and humidity conditions, and object should be compensated based on these input signals. Thus, since it is changed, the voltage, i.e., the electrostatic force, which are impressed to the electrode 409b, if the thin film 409a takes various shape which includes an aspheric surface by a situation and the polarity of the voltage impressed is changed, it can also make the shape a convex. So that there may not be the distance sensors 417 and the high frequency component of the signal of the image from the solid state image pickup device 408 may become the approximately maximum in that case, What is necessary is to move the imaging lens 403 of a digital camera, to compute the object distance conversely from the position, to change the letter mirror of good modification, and just to make it focus an observer's eye.

[0025]If the thin film 409a is manufactured with synthetic resins, such as polyimide, since the big modification also by the low voltage is possible, it is convenient. The prism 404 and the letter mirror 409 of good modification can be formed in one, and unitization can be carried out.

[0026]Although the graphic display was omitted, the solid state image pickup device 408 may be formed in one according to a lithography process on the substrate of the letter mirror 409 of good modification.

[0027]By forming by a plastic mold etc., the lens 901,902, the prism 404,405, and the mirror 406 can form the curved surface of arbitrary desired shape in ****, and are easy to manufacture. Although the lens 901,902 separates and is formed from the prism 404 in the imaging device of this example, If the prism 404,405, the mirror 406, and the letter mirror 409 of good modification are designed remove aberration, without forming the lens 901,902, the prism 404,405 and the letter mirror 409 of good modification will become one optical block, and will become easy [an assembly]. If some or all of the lens 901,902, the prism 404,405, and the mirror 406 may be produced with glass and constituted in this way, a still more accurate imaging device will be obtained.

[0028]That may not be right, although the arithmetic unit 414, the thermo sensor 415, the humidity sensor 416, and the distance sensors 417 are formed and temperature-and-humidity change, change of the object distance, etc. were compensated with the letter mirror 409 of good modification in the example of drawing 10. That is, the arithmetic unit 414, the thermo sensor 415, the humidity sensor 416, and the distance sensors 417 are excluded, and it may be made for the letter mirror 409 of good modification to amend only an observer's diopter change.

[0029]Drawing 11 is an outline lineblock diagram showing other examples of the letter mirror 409 of good modification applicable to the variable mirror used for the optical pickup of this invention. As for the letter mirror 409 of good modification of this example, the piezoelectric element 409c is infixed between the thin film 409a and the electrode 409b, and these are provided on the buck 423. And by changing into each electrode 409b of every the voltage added to the piezoelectric element 409c, the piezoelectric element 409c

can be made to produce selectively different elasticity, and the shape of the thin film 409a can be changed now. As are shown in drawing 12, and it may be same mind division and is shown in drawing 13, the form of the electrode 409b may be rectangle division, in addition can choose the thing of a proper form. Among drawing 11, it was connected to the arithmetic unit 414, and 424 sway (Bure), and are a sensor, For example, the deflection of a digital camera is detected, and the voltage impressed to the electrode 409b via the arithmetic unit 414 and the variable resister 411 is changed in order to change the thin film 409a so that disorder of the image by deflection may be compensated. At this time, the signal from the thermo sensor 415, the humidity sensor 416, and the distance sensors 417 is also simultaneously taken into consideration, and focus doubling, temperature-and-humidity compensation, etc. are performed. In this case, since the stress accompanying modification of the piezoelectric element 409c is added to the thin film 409a, the thickness of the thin film 409a is good to be made somewhat more thickly and to give suitable intensity.

[0030]Drawing 14 is an outline lineblock diagram showing the example of further others of the letter mirror 409 of good modification applicable to the variable mirror used for the optical pickup of this invention. The letter mirror of good modification of this example differs from the letter mirror of good modification of the example shown in drawing 11 at the point constituted in the piezoelectric elements 409c and 409c of two sheets made from the material in which the piezoelectric element interposed between the thin film 409a and the electrode 409b has the piezoelectric property of an opposite direction. That is, if made from the ferroelectric crystal in the piezoelectric elements 409c and 409c, it is arranged so that direction of a crystal axis may become reverse mutually. In this case, since it expands and contracts to an opposite direction if voltage is impressed in the piezoelectric elements 409c and 409c, it becomes stronger than the case of the example which the power into which the thin film 409a is changed showed to drawing 11, and there is an advantage that the form on the surface of a mirror is a lot changeable as a result.

[0031]As a material used in the piezoelectric elements 409c and 409c, For example, barium titanate, a Rochell salt, crystal, tourmaline, potassium dihydrogen phosphate (KDP), Piezo-electric substances, such as ammonium dihydrogenphosphate (ADP) and lithium niobate, The electrostrictive ceramics of the solid solution of the polycrystalline substance of the substance, the crystal of the substance, $PbZrO_3$, and $PbTiO_3$, There are organic piezo-electricity substances, such as polydifluoride vinyl (PVDF), ferroelectrics other than the above, etc., and especially an organic piezo-electricity substance has small Young's modulus, and since big modification is possible also by the low voltage, it is desirable. If thickness is made uneven when using these piezoelectric elements, it is also possible to change the shape of the thin film 409a appropriately in the above-mentioned example.

[0032]As construction material of the piezoelectric elements 409c and 409c, Polymers piezo electric crystals, such as polyurethane, silicone rubber, an acrylic elastomer, PZT, PLZT, and polyvinylidene fluoride (PVDF), a vinylidene cyanide copolymer, the copolymer of vinylidene fluoride and trifluoroethylene, etc. are used. If the organic materials which have piezoelectricity, the synthetic resin which has piezoelectricity, the elastomer which has piezoelectricity, etc. are used, big modification of the letter mirror plane of good modification is realized.

[0033]When using an electrostriction material, for example, an acrylic elastomer, silicone rubber, etc. for

drawing 11 and the piezoelectric element 409c of 15, the piezoelectric element 409c may be made into the structure which pasted together substrate 409c-1 [another] and electrostriction material 409c-2.
[0034]Drawing 15 is an outline lineblock diagram showing the example of further others of the letter mirror 409 of good modification applicable to the variable mirror used for the optical pickup of this invention. As for the letter mirror of good modification of this example, the piezoelectric element 409c is pinched by the thin film 409a and 409 d of electrodes, Voltage is impressed via the drive circuit 425 controlled by the arithmetic unit 414 between the thin film 409a and the electrode 409d. It is constituted so that voltage may be impressed also to the electrode 409b provided on the buck 423 apart from this via the drive circuit 425 controlled by the arithmetic unit 414. Therefore, the thin film 409a may be transformed into a duplex in this example by the electrostatic force by the voltage impressed between 409 d of electrodes, and the voltage impressed to the electrode 409b, There is an advantage that a response is also quicker than which thing shown in the above-mentioned example so that a nearby deformation pattern many is possible.
[0035]And if the numerals of the voltage between the thin film 409a and the electrode 409d are changed, the letter mirror of good modification can be changed into a convex and a concave surface. In that case, big modification may be performed by the piezo-electric effect, and a detailed shape change may be performed by electrostatic force. Electrostatic force may mainly be used for modification of a convex at modification of a concave surface, mainly using the piezo-electric effect. 409 d of electrodes may comprise two or more electrodes like the electrode 409b. This situation was shown in drawing 15. By this application, all of the piezo-electric effect, an electrostrictive effect, and electrostriction are collectively described as the piezo-electric effect. Therefore, an electrostriction material shall also be included in piezoelectric material.
[0036]Drawing 16 is an outline lineblock diagram showing the example of further others of the letter mirror 409 of good modification applicable to the variable mirror used for the optical pickup of this invention. The letter mirror of good modification of this example is the thing to which it might be made to have made it the shape of a reflector change using electromagnetic force, On the internal base of the buck 423, fixed mounting of the edge part of the substrate 409e with which the permanent magnet 426 consists of silicon nitride or polyimide on a crestal plane is carried out, The thin film 409a made in metal coats, such as aluminum, is attached to the surface of the substrate 409e, and the letter mirror 409 of good modification is constituted. Two or more coils 427 are allocated in the undersurface of the substrate 409e, and these coils 427 are connected to the arithmetic unit 414 via the drive circuit 428, respectively. With therefore, the output signal from the arithmetic unit 414 corresponding to change of the optical system called for in the arithmetic unit 414 by the signal from each sensor 415,416,417,424. If the respectively suitable current for each coil 427 is supplied from each drive circuit 428, each coil 427 will be opposed or adsorbed by the electromagnetic force committed between the permanent magnets 426, and the substrate 409e and the thin film 409a will be changed.
[0037]In this case, each coil 427 can send the current of a quantity different, respectively. There may be the one coil 427, and it attaches the permanent magnet 426 to the substrate 409e, and it may be made to form the coil 427 in the internal base side of the buck 423. The coil 427 is good to make by techniques, such as lithography, and it may be made to put further the iron core which consists of ferromagnetics into the coil 427.

[0038]In this case, modification of a request can be given to the substrate 409e and the thin film 409a by changing the volume density of the thin film coil 427 by a place, as shown in drawing 17. There may be the one coil 427 and the iron core which consists of ferromagnetics may be inserted in these coils 427.
[0039]Drawing 18 is an outline lineblock diagram showing the example of further others of the letter mirror 409 of good modification applicable to the variable mirror used for the optical pickup of this invention. In the letter mirror of good modification of this example, the substrate 409e is made from ferromagnetics, such as iron, and the thin film 409a as a reflection film consists of aluminum etc. In this case, since it ends even if it does not provide a thin film coil, structure is easy and a manufacturing cost can be reduced. If the electric power switch 413 is replaced by the switch for change and power supply opening and closing, the direction of the current which flows into the coil 427 can be changed, and the shape of the substrate 409e and the thin film 409a can be changed freely. Although drawing 19 shows arrangement of the coil 427 in this example and drawing 20 shows other examples of arrangement of the coil 427, these arrangement is applicable also to the example shown in drawing 16. In the example shown in drawing 16, drawing 21 shows arrangement of the permanent magnet 426 which is suitable when arrangement of the coil 427 is shown in drawing 20. That is, if the permanent magnet 426 is radiately arranged as shown in drawing 21, delicate modification can be given to the substrate 409e and the thin film 409a compared with the example shown in drawing 16. When changing the substrate 409e and the thin film 409a using electromagnetic force in this way (drawing 16 and example of drawing 18), there is an advantage that it can drive by the low voltage rather than the case where electrostatic force is used.
[0040]As mentioned above, although the example of some letter mirrors of good modification applicable to the variable mirror used for the optical pickup of this invention was described, as shown in the example of drawing 15, two or more kinds of power may be used for changing the form of a mirror. That is, the letter mirror of good modification may be changed from the inside of electrostatic force, electromagnetic force, the piezo-electric effect, magnetostriction, the pressure of a fluid, an electric field, a magnetic field, a temperature change, electromagnetic waves, etc., using two or more simultaneously. That is, if an optical property good light variation study element is made using two or more different drive methods, big modification and detailed modification can be realized simultaneously and an accurate mirror plane can be realized.
[0041]Drawing 22 is an outline lineblock diagram of an imaging system used for the imaging system using the letter mirror 409 of good modification applicable to the variable mirror used for the optical pickup of this invention, for example, the digital camera of a cellular phone, a capsule endoscope, an electronic endoscope, the digital camera for personal computers, the digital camera for PDA, etc. The imaging system of this example constitutes the one imaging unit 104 from the letter mirror 409 of good modification, the lens 902, the solid state image pickup device 408, and the control system 103. In the imaging unit 104 of this example, it is condensed in the letter mirror 409 of good modification, and image formation of the light from the object which passed along the lens 102 is carried out on the solid state image pickup device 408. The letter mirror 409 of good modification is a kind of an optical property good light variation study element, and is also called the variable focus mirror.
[0042]Even if the object distance changes, focus doubling can be carried out by changing the letter mirror

409 of good modification, and it is not necessary to drive a lens by a motor etc., and according to this example, it excels in respect of a miniaturization, a weight saving, and low power consumption. The imaging unit 104 can be used in all the examples as an imaging system of this invention. Zoom, the imaging system of variable power, and an optical system can be made from using two or more letter mirrors 409 of good modification. Drawing 22 shows the example of composition of the control system including the booster circuit of the transformer which used the coil for the control system 103. It miniaturizes, if especially a laminate type piezoelectric transformer is used. Although a booster circuit can be used for the letter mirror of good modification and variable-focus lens which use all the electrical and electric equipment of this invention, it is useful to the letter mirror of good modification in the case of using especially electrostatic force and the piezo-electric effect, and a variable-focus lens.

[0043]Drawing 23 is an outline lineblock diagram of the letter mirror 188 of good modification which takes the fluid 161 in and out with the micropump 180, and is made to transform a lens side concerning the example of further others applicable to the variable mirror used for the optical pickup of this invention. According to this example, there is a merit of becoming possible to change a lens side greatly. The micropump 180 is a small pump made from the art of a micromachine, and it is constituted, for example so that it may move by electric power. The fluid 161 is inserted between the transparent substrate 163 and the elastic body 164. As an example of the pump made from the art of a micromachine, there are a thing using heat modification, a thing using piezoelectric material, a thing using electrostatic force, etc.

[0044]Drawing 24 is an outline lineblock diagram showing one example of the micropump used for the letter mirror of good modification applicable to the variable mirror used for the optical pickup of this invention. In the micropump 180 of this example, the diaphragm 181 vibrates according to electric force, such as electrostatic force and the piezo-electric effect. In drawing 24, the example which vibrates according to electrostatic force is shown, and 182,183 are an electrode among drawing 24. The dotted line shows the diaphragm 181 when it changes. The two valves 184,185 open and close and the fluid 161 is sent to the left from the right with vibration of the diaphragm 181.

[0045]In the letter mirror 188 of good modification of this example, it functions as a letter mirror of good modification by the reflection film 189 changing into unevenness according to the quantity of the fluid 161. The letter mirror 188 of good modification is driven by the fluid 161. As a fluid, organic matters, such as a silicone oil, air, water, and jelly, and an inorganic substance can be used.

[0046]In a letter mirror of good modification, a variable-focus lens, etc. using electrostatic force and the piezo-electric effect, high tension may be needed for a drive. In that case, as shown, for example in drawing 22, it is good to constitute a control system using the transformer for pressure up, or a piezoelectric transformer. If the thin film 409a for reflection is formed also in the portion not changing, when measuring the shape of the letter mirror of good modification with an interferometer etc., it can be used as a base level and is convenient.

[0047]Drawing 25 is a figure showing the composition of an example of a variable focus mirror applicable to the variable mirror used for the optical pickup of this invention. The variable focus mirror 565 shown in drawing 25 is constituted using the variable-focus lens. Then, a variable-focus lens is explained in advance of explanation of the variable focus mirror 565.

[0048]Drawing 26 is a figure showing the theoretic composition of a variable-focus lens. The 1st lens 512a with which this variable-focus lens 511 has the lens sides 508a and 508b as the 1st and 2nd field, It has the 2nd lens 512b that has the lens sides 509a and 509b as the 3rd and 4th field, and the polymers distribution liquid crystal layer 514 provided via the transparent electrodes 513a and 513b among these lenses, and incident light is completed through the 1st and 2nd lens 512a and 512b. It connects with AC power supply 516 via the switch 515, and is made for the transparent electrodes 513a and 513b to impress an AC electric field to the polymers distribution liquid crystal layer 514 selectively. The polymers distribution liquid crystal layer 514 has and constitutes many minute polymers cells 518 of arbitrary shape, such as a globular shape and a polyhedron, which contain the liquid crystal element 517, respectively, and the polymers and the liquid crystal element 517 which constitute the polymers cell 518 coincide [liquid crystal layer] the volume with the sum of the volume occupied, respectively.

[0049]Here, the sizes of the polymers cell 518 are 2nm<=D<=lambda/5, for example, when spherical and setting to lambda wavelength of the light which uses the diameter D of the average, for example. -- It is referred to as (1). That is, since the size of the liquid crystal element 517 is not less than about 2 nm, the lower limit of the average diameter D may be not less than 2 nm. Although the upper limit of D is dependent also on thickness t of the polymers distribution liquid crystal layer 514 in the optical axis direction of the variable-focus lens 511, If large compared with lambda, according to the difference of the refractive index of polymers, and the refractive index of the liquid crystal element 517, lights are scattered about in the interface of the polymers cell 518, and since the polymers distribution liquid crystal layer 514 becomes opaque, less than lambda/5 will be preferably used so that it may mention later. High degree of accuracy may not be required depending on the optical goods for which a variable-focus lens is used, and D may be below lambda then. The transparency of the polymers distribution liquid crystal layer 514 gets so bad that thickness t is thick.

[0050]An optically uniaxial pneumatic liquid crystal molecule is used for the liquid crystal element 517, for example. The index ellipsoid of this liquid crystal element 517 serves as shape as shown in drawing 27, and is $n_{ox}=n_{oy}=n_o$. -- It is (2). However, n_o shows the refractive index of an ordinary ray and n_{ox} and n_{oy} show the refractive index of the direction of in the field containing an ordinary ray which intersects perpendicularly mutually.

[0051]Here, in the state where an electric field is not impressed for the switch 515 to the OFF 514, i.e., a polymers distribution liquid crystal layer, as shown in drawing 26, since the liquid crystal element 517 has turned to various directions, the refractive index of the polymers distribution liquid crystal layer 514 to incident light is high, and serves as a powerful lens of refracting power. On the other hand, since orientation will be carried out so that the major axis direction of an index ellipsoid may become parallel [the liquid crystal element 517] to the optic axis of the variable-focus lens 511 if an AC electric field is impressed to the polymers distribution liquid crystal layer 514 by considering the switch 515 as one as shown in drawing 28, a refractive index becomes low and serves as a weak lens of refracting power.

[0052]The voltage impressed to the polymers distribution liquid crystal layer 514 can also be changed gradually or continuously with the variable resister 519, for example, as shown in drawing 29. Since orientation of the liquid crystal element 517 is carried out so that the ellipse major axis may become parallel

to the optic axis of the variable-focus lens 511 gradually as impressed electromotive force will become high, if it does in this way, refracting power is gradually or continuously changeable.

[0053]Average-refractive-index n_{LC}' of the liquid crystal element 517 of the state shown in drawing 26, i.e., the state where an electric field is not impressed to the polymers distribution liquid crystal layer 514, here, As shown in drawing 27, when the refractive index of the major axis direction of an index ellipsoid is made into n_z, it is /3**n_{LC}' about (n_{ox}+n_{oy}+n_Z). -- It is set to (3). Average-refractive-index n_{LC} in case the above-mentioned (2) formula is realized expresses n_z as refractive-index n_e of an extraordinary ray, and are ($2n_o$+n_e) / 3**n_{LC}. -- It is given by (4). At this time, refractive-index n_A of the polymers distribution liquid crystal layer 514, When the rate of the volume of the liquid crystal element 517 which makes n_P the refractive index of the polymers which constitute the polymers cell 518, and is occupied for the volume of the polymers distribution liquid crystal layer 514 is set to ff, it is n_A=ff-n_{LC}'+(1-ff) n_P by Maxwell Garnett's principle. -- It is given by (5).

[0054]Therefore, if the curvature radius of the field inside the lenses 512a and 512b, i.e., the field by the side of the polymers distribution liquid crystal layer 514, is made into R_1 and R_2, respectively as shown in drawing 29, Focal distance f_1 of the variable-focus lens 511 is $1/f_1$= (n_A-1) ($1/R_1$-$1/R_2$). -- It is given by (6). R_1 and R_2 are taken as positive, when a center of curvature is in the image point side. The refraction by the field of the outside of the lenses 512a and 512b is removed. That is, the focal distance of the lens only by the polymers distribution liquid crystal layer 514 is given by (6) formulas.

[0055]It is an average refractive index of an ordinary ray (n_{ox}+n_{oy}) / 2=n_o' -- If referred to as (7), Refractive-index n_B of the polymers distribution liquid crystal layer 514 of the state shown in drawing 28, i.e., the state where the electric field was impressed to the polymers distribution liquid crystal layer 514, n_B=ff-n_o'+(1-ff) n_P -- Focal distance f_2 of the lens only by the polymers distribution liquid crystal layer 514 in this case since it is given by (8) is $1/f_2$= (n_B-1) ($1/R_1$-$1/R_2$). -- It is given by (9). The focal distance in the case of impressing low voltage to the polymers distribution liquid crystal layer 514 rather than being able to set to drawing 28 serves as a value between focal distance f_1 given by (6) formulas, and focal distance f_2 given by (9) formulas.

[0056]The rate of change of the focal distance by the polymers distribution liquid crystal layer 514 from the above (6) and (9) types is |(f_2-f_1)/f_2|=|(n_B-n_A)/(n_B-1) |. -- It is given by (10). Therefore, what is necessary is just to enlarge |n_B-n_A|, in order to enlarge this rate of change. Here, it is n_B-n_A=ff (n_o' - n_{LC}'). -- Since it is (11), if |n_o'-n_{LC}' | is enlarged, a rate of change can be enlarged. Practical, since n_B is 1.3 to about two, it is 0.01<=|n_o'. - n_{LC}'|<=10 -- If referred to as (12), Since the focal distance by the polymers distribution liquid crystal layer 514 is changeable 0.5% or more at the time of ff=0.5, an effective variable-focus lens can be obtained. |n_o'-n_{LC}' | cannot exceed 10 from restriction of liquid crystal material.

[0057]Next, the antecedent basis of the upper limit of the above-mentioned (1) formula is explained. 31

"Solar Energy Materials and Solar Cells", Wilson and Eck, 1993, and the 197-214th of Eleevier Science PublishersB.v. issue Page, Change of the transmissivity tau when changing the size of a polymers distribution liquid crystal is shown in "Transmission variation using scattering/transparent switching films." And to the 206th page of this literature, and drawing 6. When the radius of a polymers distribution liquid crystal is set to r and it is referred to as t= 300 micrometers, ff=0.5, n_P=1.45, n_{LC}=1.585, and lambda= 500 nm, the transmissivity tau. Becoming tau**90% at the time of r= 5 nm (D=lambda/50, D-t=lambda, 6 micrometers (however, nm and the following of the unit of D and lambda are also the same)), and becoming tau**50% with a theoretical value, at the time of r= 25 nm (D=lambda/10) is shown.

[0058]Here, if the transmissivity tau in t= 150 micrometers is presumed, assuming that the transmissivity tau will change with the exponential function of t if the case of t= 150 micrometers is presumed for example, it will become tau**71% at the time of r= 25 nm (D=lambda/10, D-t=lambda, 15 micrometers). In the case of t= 75 micrometers, it becomes tau**80% similarly at the time of r= 25 nm (D=lambda/10, D-t=lambda, 7.5 micrometers).

[0059]D-t<=lambda from these results, and 15 micrometers -- If it is (13), tau will be 70% - not less than 80%, and will be used enough as a lens. Therefore, for example, in the case of t= 75 micrometers, it is D<=lambda/5, and sufficient transmissivity will be obtained.

[0060]The transmissivity of the polymers distribution liquid crystal layer 514 becomes so good that the value of n_P is close to the value of n_{LC}'. On the other hand, if it becomes a value from which n_o' and n_P differ, the transmissivity of the polymers distribution liquid crystal layer 514 will worsen. It is $n_P=(n_o'+n_{LC}')/2$ that are with the state of drawing 26 and the state of drawing 28, and the transmissivity of the polymers distribution liquid crystal layer 514 becomes good on the average. -- It is a time of satisfying (14).

[0061]Here, since the variable-focus lens 511 is used as a lens, almost similarly [transmissivity] the higher one is good [the variable-focus lens] also in the state of the state of drawing 26, or drawing 28. For that purpose, although the material of polymers and the material of the liquid crystal element 517 which constitute the polymers cell 518 have restriction, it is $n_o'<=n_P<=n_{LC}'$ practical. -- What is necessary is to just be referred to as (15).

[0062]If the above-mentioned (14) formula is satisfied, the above-mentioned (13) formula will be eased further, and they are D-t<=lambda and 60 micrometers. -- What is necessary is just (16). Because, since reflectance is proportional to the square of refractive index difference according to Fresnel's reflective rule, It is because reflection of the light in the boundary of the polymers and the liquid crystal element 517 which constitute the polymers cell 518, i.e., reduction of the transmissivity of the polymers distribution liquid crystal layer 514, is proportional to the square of the difference of the refractive index of the above-mentioned polymers and the liquid crystal element 517 about.

[0063]The above is D-t<=lambda, 15micrometer, and$(1.585-1.45)^2/(n_u-n_P)^2$, when it more generally formulizes, although it was a case of n_o'**1.45, n_{LC}' **1.585. -- What is necessary is just (17). However, $(n_u-n_P)^2$ is the larger one among $(n_{LC}'-n_P)^2$ and $(n_o'-n_P)^2$.

[0064]Although the one where the value of ff is larger is good, since the volume of polymers serves as zero

and it becomes impossible to form the polymers cell 518 in ff=1 in order to enlarge the focal distance change of the variable-focus lens 511, it is 0.1<=ff<=0.999. -- It is referred to as (18). On the other hand, since tau improves so that ff is small, the above-mentioned (17) formula is $4x10^{-6}$ preferably. [mum] ^{2}<=D-t<=lambda, 45micrometer, and$(1.585-1.45)^2/(n_u-n_P)^2$ -- It is referred to as (19). Since it is t=D, and D is not less than 2 nm as mentioned above so that clearly [the lower limit of t] from drawing 26, the lower limit of D-t is $(2x10^{-3}$mum$)^2$, i.e., $4x10^{-6}$. [mum] It becomes ^{2}.

[0065]D is when larger than 10 nm - 5 nm as it is indicated to the 58th page of Mukai ["whom Iwanami science library 8 asteroid comes"] right work, 1994, and the Iwanami Shoten issue that the approximation which expresses the optical property of a substance with a refractive index is realized. Since dispersion of the light in the interface of the polymers and the liquid crystal element 517 which dispersion of light becomes geometric and constitute the polymers cell 518 will increase according to Fresnel's reflection type if D exceeds 500 lambda, D is 7nm<=D<=500lambda practical. -- It is referred to as (20).

[0066]Drawing 30 shows the composition of the imaging optical system for the digital cameras using the variable-focus lens 511 shown in drawing 29. In this imaging optical system, image formation of the objective (not shown) image is carried out via the diaphragm 521, the variable-focus lens 511, and the lens 522 on the solid state image pickup device 523 which consists of CCD. The graphic display of the liquid crystal element is omitted in drawing 30.

[0067]According to this imaging optical system, the volts alternating current impressed to the polymers distribution liquid crystal layer 514 of the variable-focus lens 511 with the variable resister 519 is adjusted, From changing the focal distance of the variable-focus lens 511, it becomes possible, for example to the object distance from infinite distance to 600 mm to make it focus continuously, without moving the variable-focus lens 511 and the lens 522 to an optical axis direction.

[0068]Drawing 31 is a figure showing the composition of an example of a variable focus diffraction optical element which used the principle of the variable-focus lens. The 1st transparent substrate 532 that has the 1st and 2nd field 532a and 532b where this variable focus diffraction optical element 531 is parallel, It has the 2nd transparent substrate 533 that has the 3rd field 533a and 4th flat field 533b in which the ring shape diffraction grating of the shape of a section serration wave which has a channel depth of the wavelength order of light was formed, and incident light is made to emit through the 1st and 2nd transparent substrate 532,533. Between the 1st and 2nd transparent substrate 532,533, With drawing 26 having explained, the polymers distribution liquid crystal layer 514 is formed via the transparent electrodes 513a and 513b, the transparent electrodes 513a and 513b are similarly, connected to AC power supply 516 through the switch 515, and it is made to impress an AC electric field to the polymers distribution liquid crystal layer 514.

[0069]The beam of light which enters into the variable focus diffraction optical element 531 in this composition is psintheta=mlambda, if the lattice pitch of the 3rd field 533a is set to p and m is made into an integer. -- Only the angle theta which fills (21) is deflected and emitted. If the refractive index of h and the transparent substrate 33 is made into n_{33} for a channel depth and k is made into an integer, it is $h(n_A-n_{33})$ =mlambda. -- (22) $h(n_B-n_{33})$ =klambda -- If (23) is filled, diffraction efficiency will be 100% on the wavelength

lambda, and generating of the flare can be prevented.

[0070]Here, it is $h(n_A-n_B)$ =(m-k)lambda if the difference of the both sides of the above (22) and (23) types is searched for. -- (24) is obtained. Therefore, for example, if lambda= 500 nm, n_A=1.55, and n_B=1.5, it will be set to 0.05h= (m-k) and 500 nm, and it will be set to h= 10000 nm = 10 micrometers if m= 1 and k= 0. In this case, refractive-index n_{33} of the transparent substrate 533 should just be n_{33}=1.5 from the above-mentioned (22) formula. If lattice pitch p in the periphery of the variable focus diffraction optical element 531 shall be 10 micrometers, it becomes theta**2.87 degrees and the f number can obtain the lens of 10.

[0071]Since this variable focus diffraction optical element 531 changes light path length by turning on and off of the impressed electromotive force to the polymers distribution liquid crystal layer 514, it can be used for using for the light flux of a lens system arranging for example, into the portion which is not parallel, and performing focus adjustment, or changing the focal distance of the whole lens system, etc.

[0072]In this embodiment, the above-mentioned (22) - (24) type, Practically, it is $0.7m\lambda \leq h(n_A-n_{33}) \leq 1.4m\lambda$. -- [-- What is necessary is just to fill (27).] (25) $0.7k\lambda \leq h(n_B-n_{33}) \leq 1.4k\lambda$ -- (26) $0.7(m-k)\lambda \leq h(n_A-n_B) \leq 1.4(m-k)\lambda$

[0073]There is also a variable-focus lens using a twist pneumatic liquid crystal. Drawing 32 and drawing 33 show the composition of the variable focus glasses 550 in this case, and the variable-focus lens 551, The lenses 552 and 553 and the orienting films 539a and 539b provided via the transparent electrodes 513a and 513b, respectively on the inner surface of these lenses, The twist pneumatic liquid crystal layer 554 provided among these orienting films is had and constituted, the transparent electrodes 513a and 513b are connected to AC power supply 516 through the variable resister 519, and it is made to impress an AC electric field to the twist pneumatic liquid crystal layer 554.

[0074]When voltage impressed to the twist pneumatic liquid crystal layer 554 is made high, in this composition the liquid crystal element 555, As shown in drawing 33, it becomes a homeotropic orientation, and compared with the case where it is in the twist pneumatic state where the impressed electromotive force shown in drawing 32 is low, the refractive index of the twist pneumatic liquid crystal layer 554 becomes small, and a focal distance becomes long.

[0075]Since it is necessary to make small enough here the spiral pitch P of the liquid crystal element 555 in the twist pneumatic state shown in drawing 32 in the same grade compared with the wavelength lambda of light, it is $2nm \leq P \leq 2\lambda/3$, for example. -- It is referred to as (28). The lower limit of this condition is decided by the size of a liquid crystal element, and upper limit, If it is a value required in order that the twist pneumatic liquid crystal layer 554 may act as an isotropic medium in the state of drawing 32 and the conditions of this upper limit are not fulfilled when incident light is available light, Only the image in which it became a lens which differs in a focal distance, the this double image was formed in of the polarization direction, and the variable-focus lens 551 faded by it is acquired.

[0076]Drawing 34 (a) shows the composition of the variable declination prism adapting the principle of the variable-focus lens. This variable declination prism 561 is provided with the following.

The 1st transparent substrate 562 by the side of the incidence which has the 1st and 2nd field 562a and

562b.
The 2nd transparent substrate 563 of the shape of a parallel plate by the side of the outgoing radiation which has the 3rd and 4th field 563a and 563b.
The inner surface (the 2nd field) 562b of the transparent substrate 562 by the side of incidence is formed in the shape of Fresnel, and the polymers distribution liquid crystal layer 514 is similarly formed via the transparent electrodes 513a and 513b with drawing 26 having explained between this transparent substrate 562 and the transparent substrate 563 by the side of outgoing radiation. It connects with AC power supply 516 through the variable resister 519, and the transparent electrodes 513a and 513b impress an AC electric field to the polymers distribution liquid crystal layer 514 by this, and control the angle of deviation of the light which penetrates the variable declination prism 561. Although the inner surface 562b of the transparent substrate 562 was formed in the shape of Fresnel in drawing 34 (a), For example, as shown in drawing 34 (b), it can also form in the shape of [which could also be formed in the shape of / which has the inclined plane which made the inner surface of the transparent substrates 562 and 563 incline relatively / usual / prism, or was shown in drawing 31] a diffraction grating. In forming in the shape of a diffraction grating, the above-mentioned (21) - (27) type is applied similarly.
[0077]The variable declination prism 561 of this composition can be effectively used as objects for the Bure prevention, such as a TV camera, a digital camera, a film camera, and binoculars, for example. In this case, the inflecting direction (deflection direction) of the variable declination prism 561, Although it is desirable to consider it as a sliding direction, in order to raise performance further, as a deflection direction is changed, for example, the two variable declination prisms 561 are shown in drawing 35, it is desirable to arrange so that an angle of refraction may be changed towards the upper and lower sides and right and left intersecting perpendicularly. The graphic display of the liquid crystal element is omitted in drawing 34 and drawing 35.
[0078]And the variable focus mirror 565 shown in drawing 25 also applies the principle of a variable-focus lens. This variable focus mirror 565 is provided with the following.
The 1st transparent substrate 566 that has the 1st and 2nd field 566a and 566b.
The 2nd transparent substrate 567 that has the 3rd and 4th field 567a and 567b.
Form the 1st transparent substrate 566 plate-like or in the shape of a lens, form the transparent electrode 513a in the inner surface (the 2nd field) 566b, and the 2nd transparent substrate 567, The inner surface (the 3rd field) 567a is formed in concave shape, the reflection film 568 is given on this concave surface, and the transparent electrode 513b is further formed on this reflection film 568. With drawing 26 having explained between the transparent electrode 513a and 513b, the polymers distribution liquid crystal layer 514 is formed, these transparent electrodes 513a and 513b are similarly, connected to AC power supply 516 through the switch 515 and the variable resister 519, and it is made to impress an AC electric field to the polymers distribution liquid crystal layer 514. The graphic display of the liquid crystal element is omitted in drawing 25.
[0079]According to this composition, the beam of light which enters from the transparent substrate 566 side, Since it becomes an optical path which turns up the polymers distribution liquid crystal layer 514 with the reflection film 568, an operation of the polymers distribution liquid crystal layer 514 can be given twice, and the focal position of catoptric light is changeable by changing the impressed electromotive force to the

polymers distribution liquid crystal layer 514. In this case, since the beam of light which entered into the variable focus mirror 565 penetrates the polymers distribution liquid crystal layer 514 twice, if it is made twice the thickness of the polymers distribution liquid crystal layer 514 into t, each of above-mentioned formulas can be similarly used for it. The inner surface of the transparent substrate 566 or 567 can be made into the shape of a diffraction grating as shown in drawing 31, and thickness of the polymers distribution liquid crystal layer 514 can also be made thin. If it does in this way, there is an advantage which can lessen the scattered light more.

[0080]In order to prevent degradation of a liquid crystal, it was made to impress an AC electric field to a liquid crystal in the above explanation, using AC power supply 516 as a power supply, but a direct-current electric field can be impressed to a liquid crystal using DC power supply. It is good also by changing the frequency of the electric field applied to a liquid crystal as a method of changing the direction of a liquid crystal element, besides changing voltage, the magnetic field strength and frequency which are applied to a liquid crystal, or the temperature of a liquid crystal. Since a polymers distribution liquid crystal is not liquefied and there is also a thing near a solid in the example of composition shown above, In that case, there may not be one side of the transparent substrate [in / on the other hand / the transparent substrate / in / on the other hand / drawing 34 (a) / 563 of the transparent substrate 532, the lens 538, and the lens 552,553 and drawing 34 (b)] 562,563 of the lenses 512a and 512b and one side of the transparent substrate 566,567. In this application, a variable focus mirror like drawing 25 from which shape does not change shall also be included into the letter mirror of good modification.

[0081]Drawing 36 is an outline lineblock diagram showing the example of further others of the letter mirror of good modification applicable to the variable mirror used for the optical pickup of this invention. This example explains as what is used for a digital camera. As for a thermo sensor and 416, a variable resister and 414 are [distance sensors and 424] shake sensors a humidity sensor and 417 an arithmetic unit and 415 411 among drawing 36. The letter mirror 45 of good modification of this example separates the electrostriction material 453 which consists of organic materials, such as an acrylic elastomer, and between, and forms the divided electrode 409b, The electrode 452 and the deformable substrate 451 are formed in order on the electrostriction material 453, the reflection film 450 which consists of metal, such as aluminum which reflects incident light on it further, is formed, and it is constituted. When constituted in this way, there is a merit of the face shape of the reflection film 450 becoming smooth, and becoming compared with the case where the divided electrode 409b is united with the electrostriction material 453 it being hard to generate aberration optically. Reverse may be sufficient as arrangement of the deformable substrate 451 and the electrode 452. 449 are a button which performs variable power of an optical system, or zoom among drawing 36, and the letter mirror 45 of good modification is made to transform the form of the reflection film 450 because a user pushes the button 449, and is controlled via the arithmetic unit 414 to be able to carry out variable power or zoom. Piezoelectric material, such as barium titanate already described instead of the electrostriction material which consists of organic materials, such as an acrylic elastomer, may be used.

[0082]Finally, the definition of term used by this invention is described.

[0083]An optical apparatus is a device containing an optical system or an optical apparatus. It is not necessary to function with an optical apparatus simple substance. That is, some devices may be used.

[0084]An imaging device, a viewing device, a display, a lighting system, a signal processor, etc. are contained in an optical apparatus.
[0085]As an example of an imaging device, there are an eye of a film camera, a digital camera, and a robot, a lens replacement type digital single lens reflex camera, a television camera, a moving image recorder, an electronic moving image recorder, a camcorder, a VTR camera, an electronic endoscope, etc. Each of a digital camera, a card shape digital camera, television cameras, VTR cameras, recording animation cameras, etc. is examples of an electronic imaging device.
[0086]As an example of a viewing device, there are a microscope, a telescope, glasses, binoculars, a magnifying glass, fiberscope, a finder, a view finder, etc.
[0087]As an example of a display, a liquid crystal display, a view finder, a game machine (PlayStation by Sony Corp.), There are a video projector, a liquid crystal projector, a head wearing type image display device (head mounted display:HMD), PDA (Personal Digital Assistant), a cellular phone, etc.
[0088]As an example of a lighting system, there are a stroboscope of a camera, a headlight of a car, an endoscope light source, a microscope light source, etc.
[0089]As an example of a signal processor, there are a cellular phone, a personal computer, a game machine, reading and the write apparatus of an optical disc, an arithmetic unit of an optical computer, etc.
[0090]An image sensor points out CCD, an image pick-up tube, a solid state image pickup device, a photographic film, etc., for example. A plane-parallel plate shall be contained in one of the prism. Change of a diopter scale shall be included in an observer's change. Change of the object distance used as a photographic subject, movement of an object, a motion of an object, vibration, blur of an object, etc. shall be included in change of a photographic subject.
[0091]The definition of an extended curved surface is as follows. The surface of a sphere which carried out eccentricity to the optic axis besides a surface of a sphere, a flat surface, and a symmetry-of-revolution aspheric surface, a flat surface, a symmetry-of-revolution aspheric surface or the aspheric surface that has a symmetry plane, the aspheric surface which has only one symmetry plane, the aspheric surface without a symmetry plane, the free sculptured surface, the point in which differentiation is impossible, the field which has a line, etc. may have what kind of form. What is necessary is just a field which can have a certain influence on light also by the reflector or a refracting interface. In this invention, these will be generically called an extended curved surface.
[0092]With an optical property good light variation study element, a variable-focus lens, a variable mirror, the polarizing prism that changes face shape, a vertical angle variable prism, the variable diffraction optical element which changes an optical deflection operation, jam variable HOE, variable DOE, etc. are included.
[0093]A variable lens from which a focal distance does not change but an aberration amount changes shall also be included in a variable-focus lens. The same may be said of a variable mirror. In short, that from which an optical deflection operation of reflection of light, refraction, diffraction, etc. may change is called an optical property good light variation study element by an optical element.
[0094]An information sender refers to the device which can input and transmit a certain information on remote controls, such as a cellular phone, a stationary type telephone, a game machine, television, a radio cassette recorder, and a stereo, the keyboard of a personal computer and a personal computer, a mouse, a

touch panel, etc. The monitor of a television monitor and a personal computer and a display with an imaging device shall also be included. An information sender is contained in a signal processor.

[0095]As explained above, the optical pickup of this invention is provided with the feature shown in the following other than the statement of a claim.

[0096](1) The optical pickup according to claim 1 or 2 for which said variable mirror is characterized by the shape of said mirror surface changing to the concave surface and convex of a flat surface or the shape of curvature faces.

[0097](2) The optical pickup according to claim 1 or 2 for which said variable mirror is characterized by the shape of said mirror surface changing to a flat surface or a curvature-faces-like concave surface.

[0098](3) The optical pickup according to claim 1 or 2 for which said variable mirror is characterized by the shape of said mirror surface changing to a flat surface or a curvature-faces-like convex.

[0099](4) The optical pickup according to claim 2, wherein said variable mirror amends the spherical aberration generated by the substrate thickness error of said recording medium by changing the shape of said mirror surface.

[0100](5) The optical pickup according to claim 2, wherein said variable mirror amends the coma aberration generated by inclination of said recording medium and curvature by changing the shape of said mirror surface.

[0101](6) The optical pickup according to claim 2, wherein said variable mirror amends the spherical aberration generated by the substrate thickness error of said recording medium by changing the shape of said mirror surface, and the coma aberration generated by curvature.

[0102](7) An optical pickup given in either above-mentioned (1) claims 1 and 2, wherein said variable mirror is constituted using the piezoelectric material which has the electrode divided into plurality or - (6).

[0103](8) An optical pickup given in either above-mentioned (1) claims 1 and 2, wherein said variable mirror has the permanent magnet or coil arranged near the optical surface, and a member which can send the current united with the optical surface and changes face shape according to electromagnetic force or - (6).

[0104](9) An optical pickup the above (7) provided with the shape variable optical element which can be used common to two or more optical apparatuses as said variable mirror also of an identical configuration is, or given in (8).

[0105](10) An optical pickup given in either above-mentioned (1) claims 1 and 2, wherein said variable mirror is controlled by the electrical and electric equipment or - (9).

[0106](11) An optical pickup given in either above-mentioned (1) claims 1 and 2 driving said variable mirror with static electricity or - (9).

[0107](12) An optical pickup given in either above-mentioned (1) claims 1 and 2 driving said variable mirror according to electromagnetic force or - (9).

[0108](13) An optical pickup given in either above-mentioned (1) claims 1 and 2 driving said variable mirror by the piezo-electric effect or electrostriction or - (9).

[0109]

[Effect of the Invention]According to this invention, power consumption is small, a sound is quiet, response time is short, and mechanical structure is easy, and the optical pickup which contributes to a cost cut can be

provided.

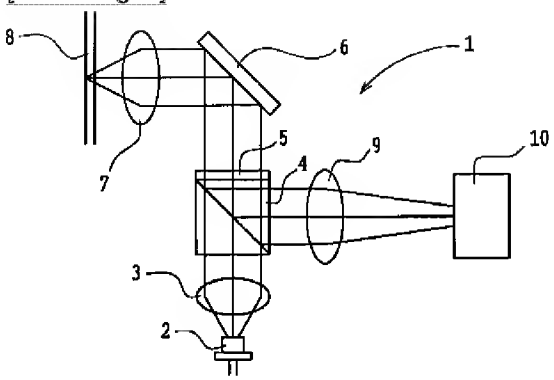
[Translation done.]

* NOTICES *

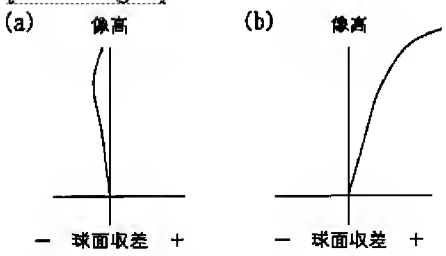
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

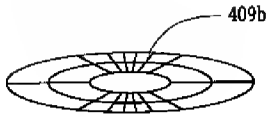
[Drawing 1]



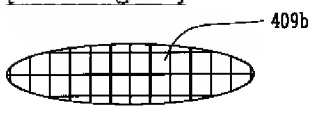
[Drawing 2]



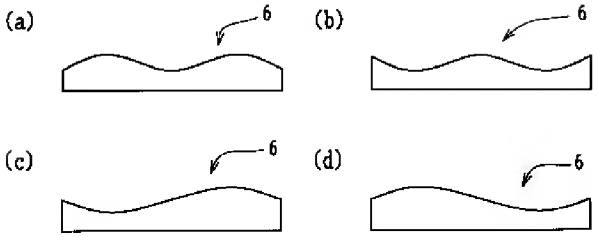
[Drawing 12]



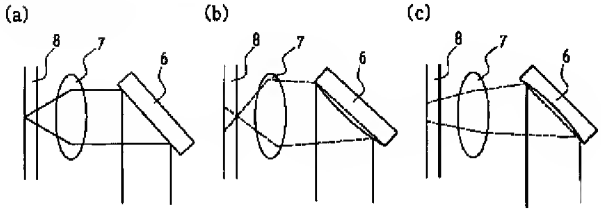
[Drawing 13]



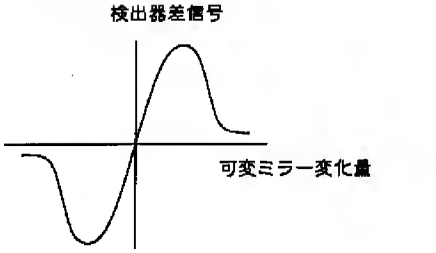
[Drawing 3]



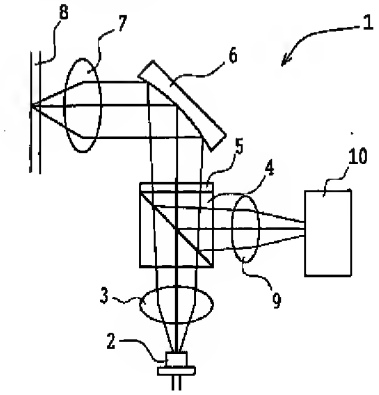
[Drawing 4]



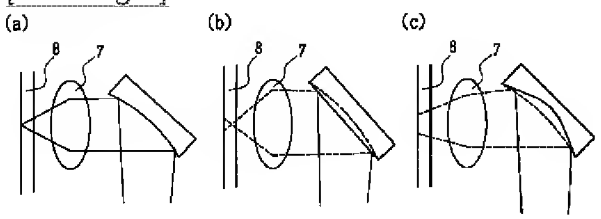
[Drawing 5]



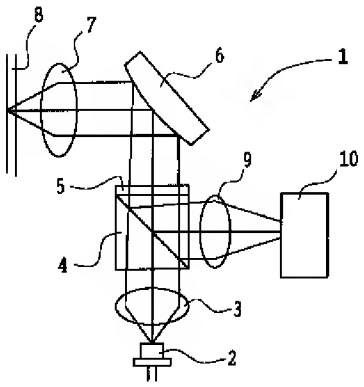
[Drawing 6]



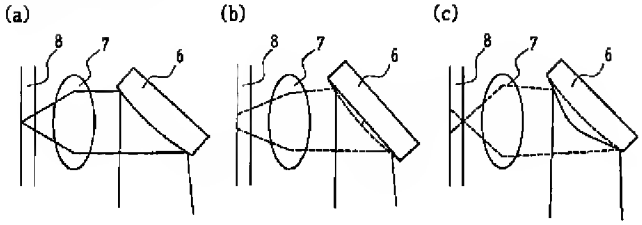
[Drawing 7]



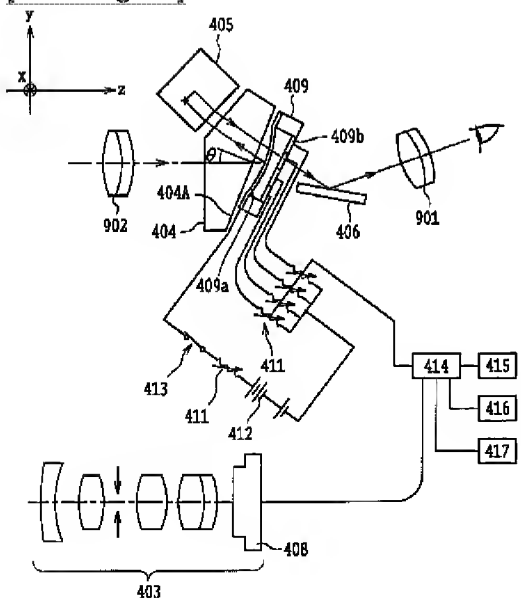
[Drawing 8]



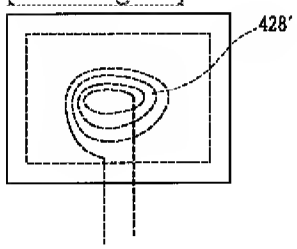
[Drawing 9]



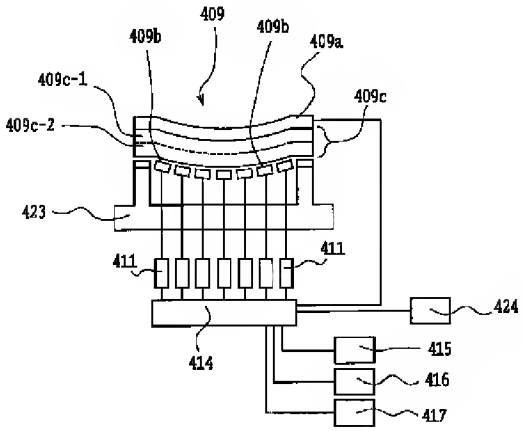
[Drawing 10]



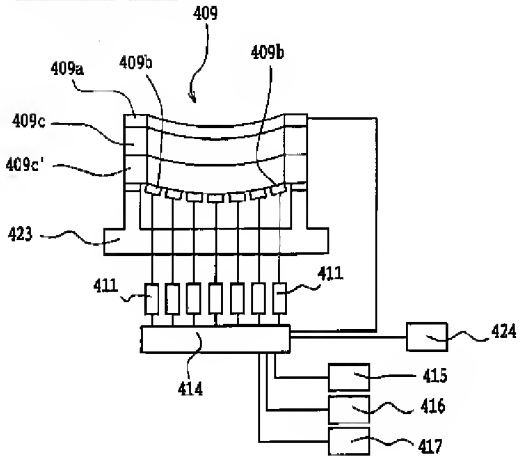
[Drawing 17]



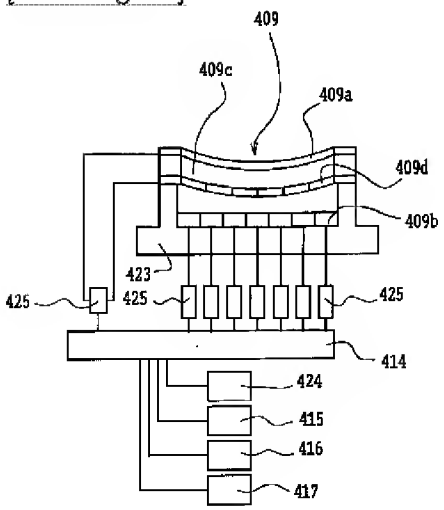
[Drawing 11]



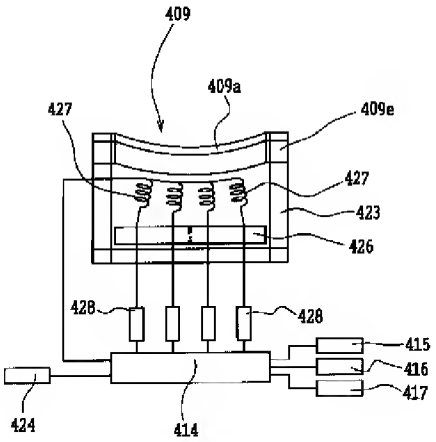
[Drawing 14]



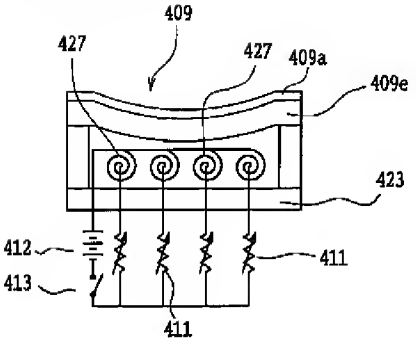
[Drawing 15]



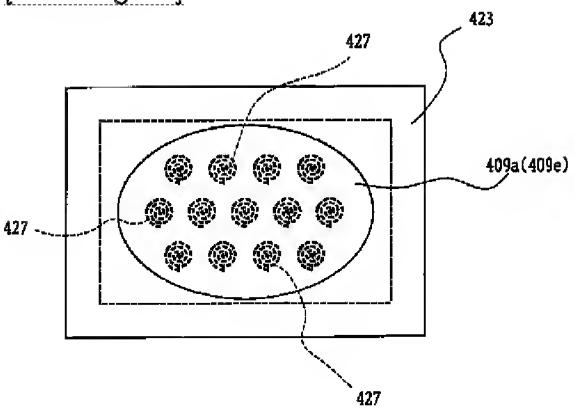
[Drawing 16]



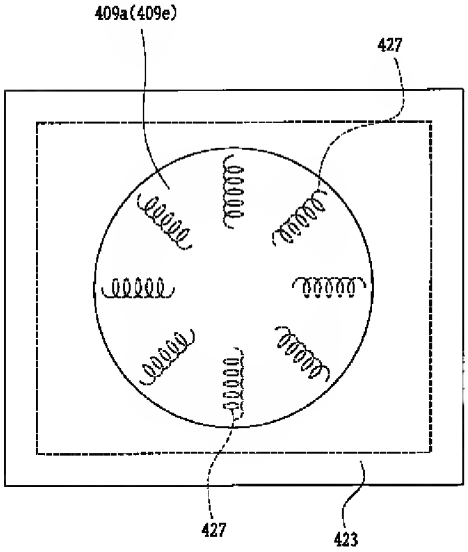
[Drawing 18]



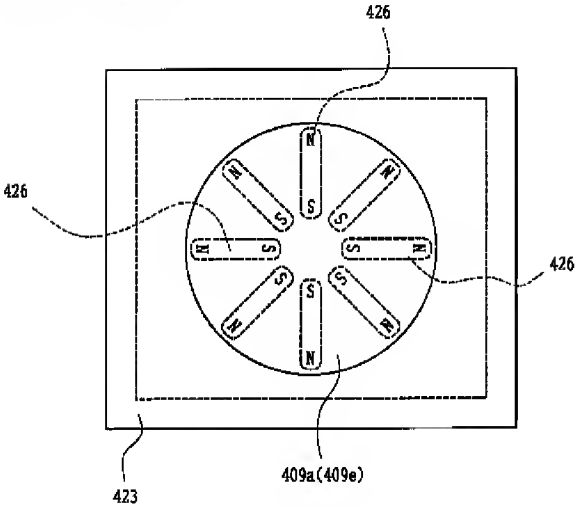
[Drawing 19]



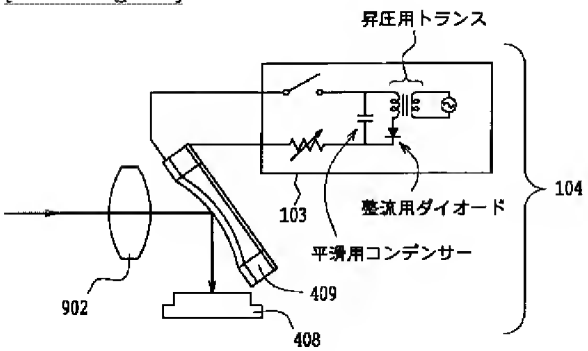
[Drawing 20]



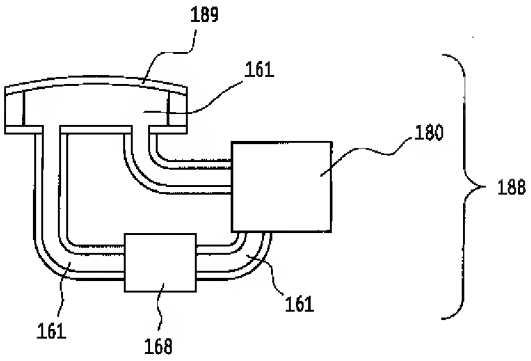
[Drawing 21]



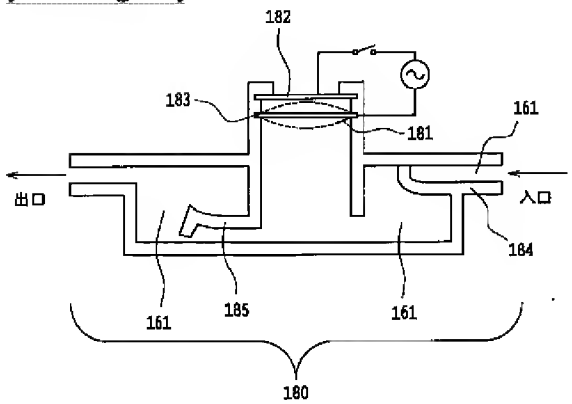
[Drawing 22]



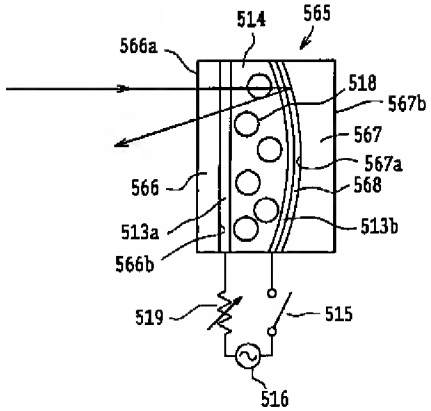
[Drawing 23]



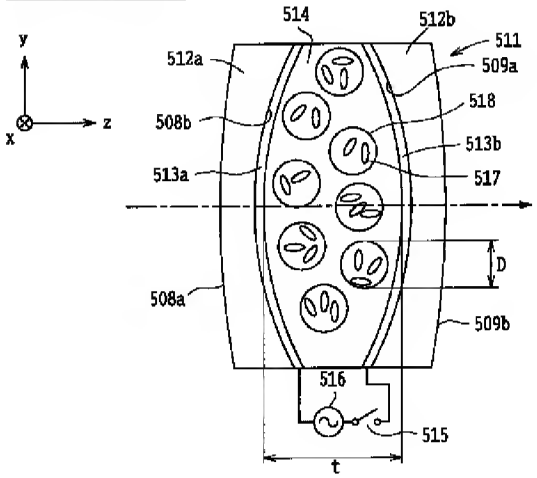
[Drawing 24]



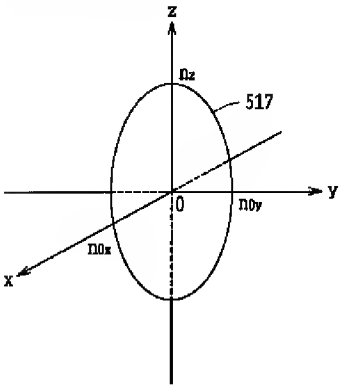
[Drawing 25]



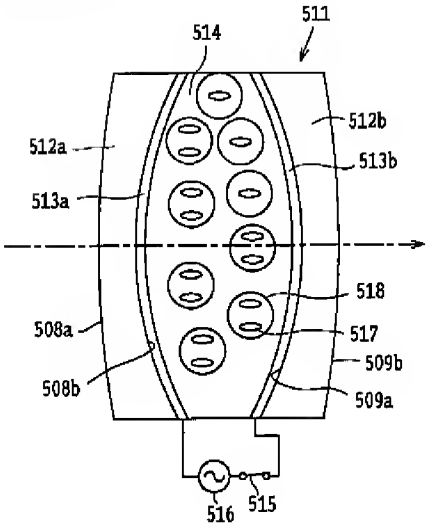
[Drawing 26]



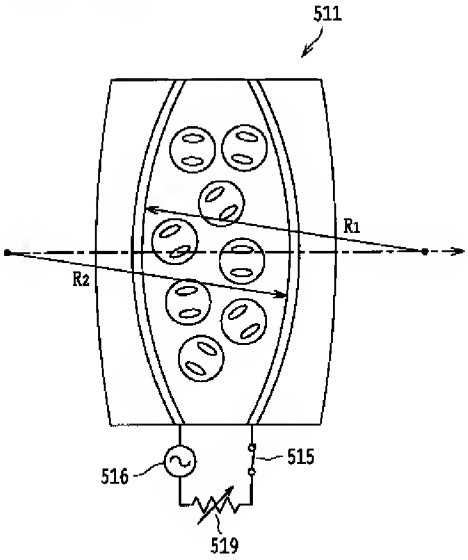
[Drawing 27]



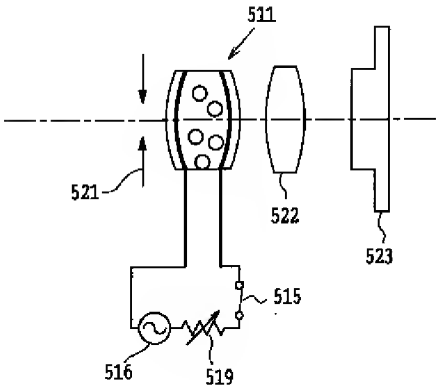
[Drawing 28]



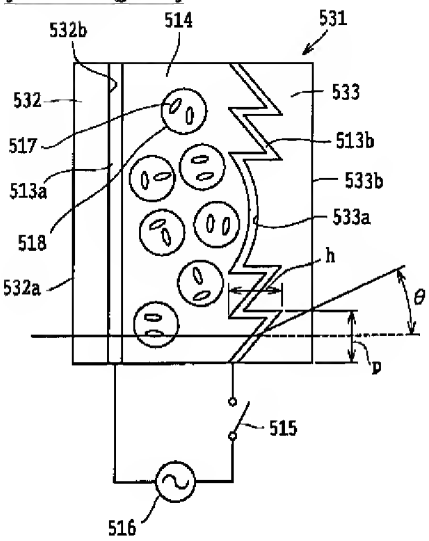
[Drawing 29]



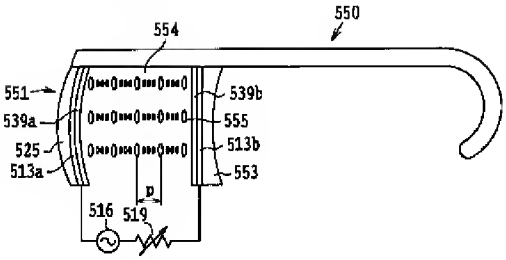
[Drawing 30]



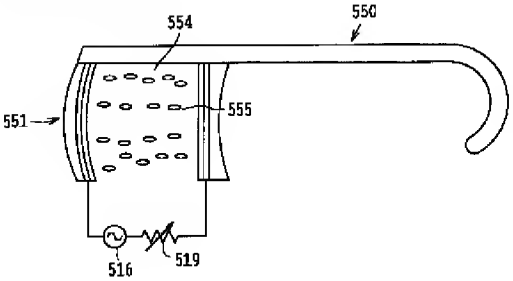
[Drawing 31]



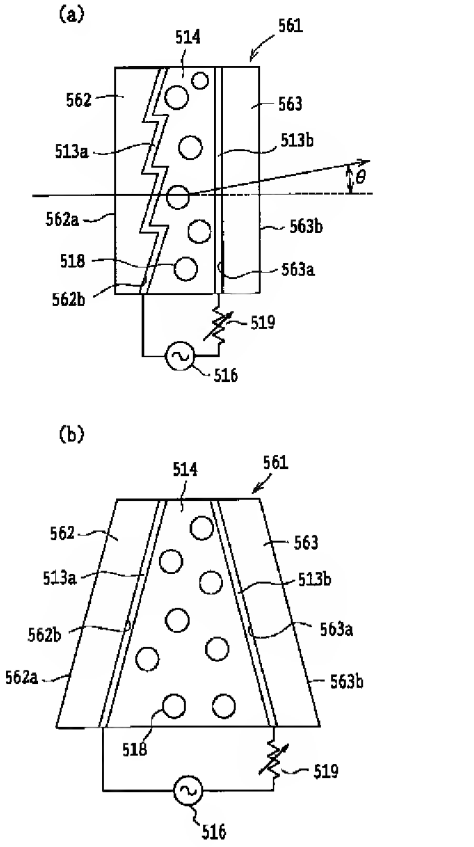
[Drawing 32]



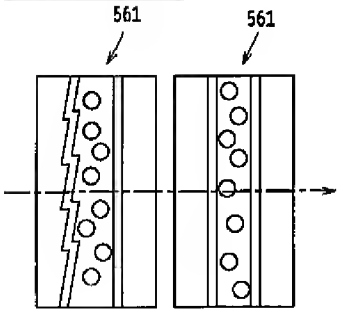
[Drawing 33]



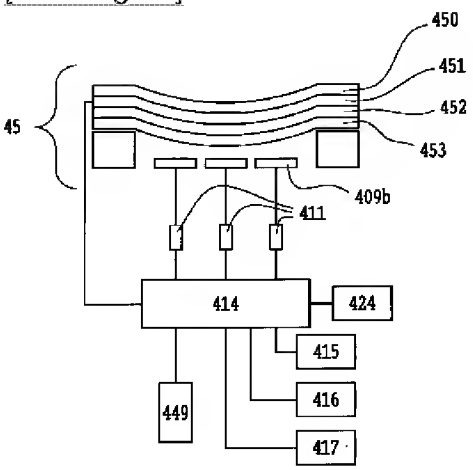
[Drawing 34]



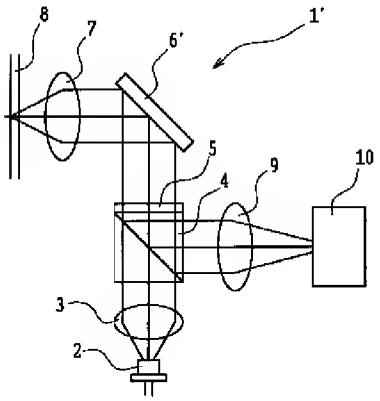
[Drawing 35]



[Drawing 36]



[Drawing 37]



[Translation done.]